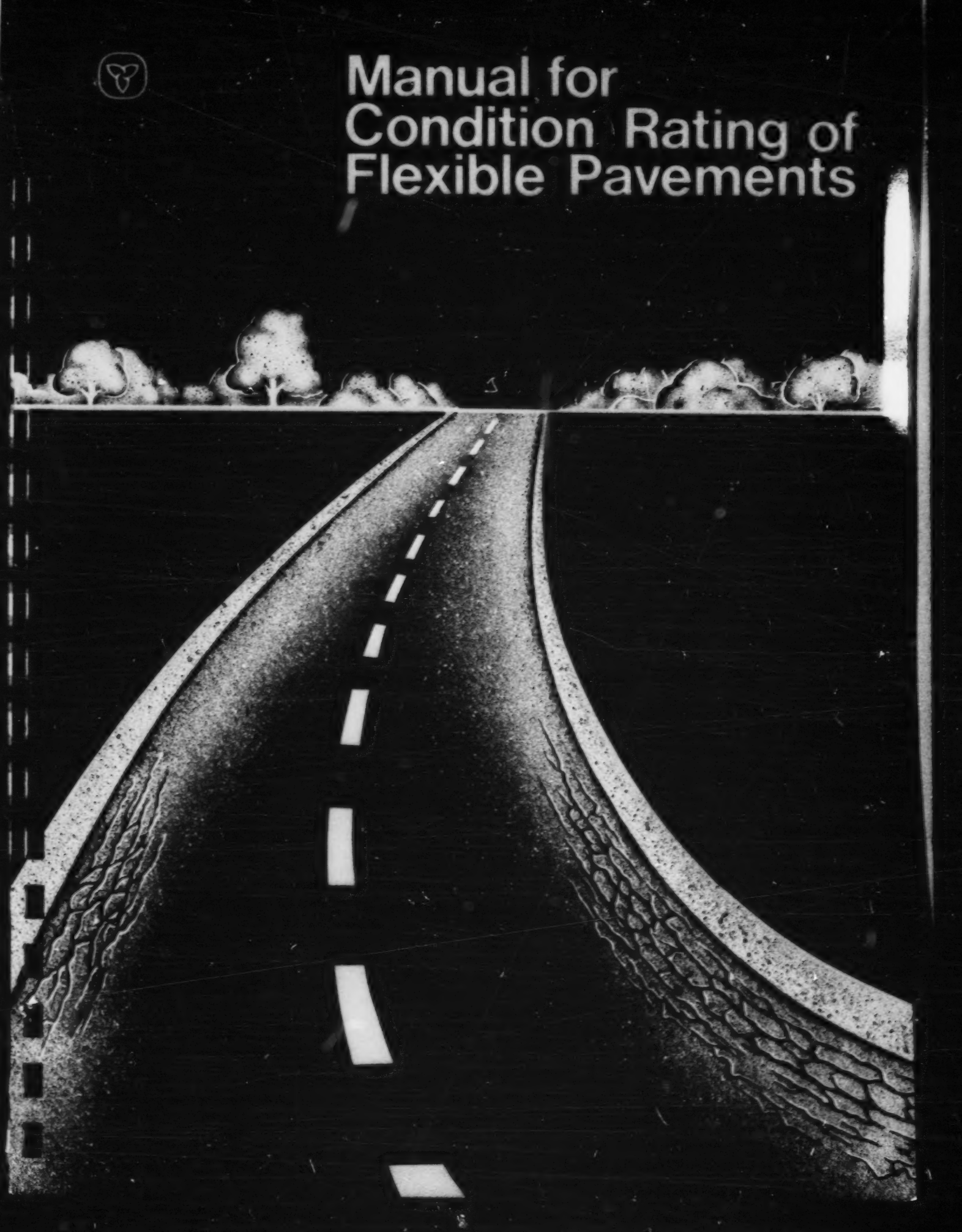
Manual for Condition Rating of Flexible Pavements



Ontario

Ministry of
Transportation and
Communications

Manual for Condition Rating of Flexible Pavements

Distress Manifestations

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1. Introduction

Rating of pavement surface condition is used in one form or another by most highway authorities as a measure of the ability of the pavement to continue to provide required service to the public. The more important uses for condition ratings are their use in determining deficiencies, inadequacies, remedial measures, fiscal needs, and in programing. The surface condition rating scheme used in Ontario is based on two interrelated measures — riding quality and distress manifestations.

Riding quality, while it is a subjective measure depending on personal opinion, on regional bias, and on observer experience, can be measured quantitatively by mechanical devices such as Roughometers and Profilometers. Distress manifestations have not previously been quantified, but this is needed if more meaningful use is to be made of condition ratings. Distress manifestations are categorized and illustrations of each category are provided to lend uniformity to reporting and interpretation. In addition, descriptions of the density of occurrence and the severity of the particular distress manifestation are made to conform with standard words which express the relative density or severity on a scale which may be quantified from 1 to 5. Examples of use of these descriptions of distress manifestations are given, such as 'slight multiple longitudinal wheel-track cracks occurring at frequent intervals over the section.' In this example, the words 'slight' and 'frequent' are the standard words which correspond to Numbers 2 and 3 on the severity and density scales. Guidelines and photographs are provided to control usage of the standard words.

Probable causes of each distress manifestation are presented, together with comments on progressive deterioration or other behaviour which might affect remedial treatment.

Although the purpose of this manual is to describe distress manifestations of the pavement, possible matching remedial measures are suggested under each distress manifestation. However, it should be understood that the possible remedial measures listed against a deficiency might not necessarily be the most effective maintenance alternative, nor will these measures necessarily effectively correct the cause or causes of the distress. That is, the listed remedial measure may only be as an expedient maintenance treatment to slow the deterioration.

2. Pavement Surface Condition Rating Scheme

The rating scheme devised and used in Ontario at present is shown in Table B-1 of the Appendix. It presents a rating scale of 0 to 100 and the locations on this scale for separating different timing and types of remedial action together with their corresponding descriptions of surface condition in terms of riding quality, distortion and the severity, extent and type of cracking distress. The scheme is valid; however, more value can be obtained from Condition Reports if a formalized and uniformly-worded description of the distress manifestation is implemented. Such descriptions aid in decisions regarding the choice of remedial treatment which has the best probable chance of success, add to performance evaluation of different pavement designs, allow identification of specific problems or weaknesses, and permit quantitative analysis of type, extent and location of distress manifestations.

Condition rating consists of a rater evaluating two different physical parameters: the riding quality of the pavement surface, and the extent and severity of distress manifestations. The two physical parameters are interrelated by reason that some distress manifestations result in surface distortion and unevenness which then cause a reduction in riding quality. However, rougher pavements, in turn, cause vehicles to produce higher dynamic wheel loads, thus increasing stresses, strains, and deflections and hastening deterioration. Not all distress manifestations are accompanied by distortion or unevenness. The type of distress and the extent and severity of occurrence are all very useful indicators of structural inadequacy, material deficiency, and probable rate of subsequent deterioration.

Riding quality of the pavement is measurable by means of mechanical devices such as Roughometers and Profilometers. The roughness is expressed as a number of millimetres of vertical motion per kilometre. However, such devices are too slow and inconvenient for regular usage and must be checked and calibrated at frequent intervals, thus making them expensive and, at times, unavailable. Since riding quality is a perceived measure, it is quite practical for the rater to attempt to evaluate ride quality. This ability improves with experience, but there is a need for a rater to be aware, at all times, of the condition and characteristics of the vehicle which he is using.

Distress manifestations may be grouped under three main headings: surface defects, distortion or permanent deformation, and cracking. In a general way, it can be said that surface defects result from a combination of construction circumstances such as mix proportioning, the aggregates used, the asphalt cement grade, and on traffic, the environment, and age. In the same way, it can be said that distortion or permanent deformation results from unstable or poorly designed or controlled asphalt mixes on inadequate structures, from consolidation of the materials comprising the structure and subgrade, from settlements, and from embankment slip failures. It can also be said that cracking results from traffic loading, or from thermally- or environmentally-induced forces. The different distress manifestations have been assigned names, which are listed in Figure 1. Each type of distress is evaluated in terms of the extent or density of occurrence and in terms of its severity. Uniform word descriptions are suggested to correspond with each category of density or severity.

Condition ratings generally apply to whole contract or project lengths involving many kilometres of pavement. To make the rating reports more useful, condition ratings of subsections may be undertaken. A preliminary evaluation of ride quality may enable the rater to identify subsections with substantially different qualities, and the project may be subdivided by such changes; however, it is suggested that subsections should be between 2 km and 5 km in length. Occasionally, newer pavements exhibit essentially uniform conditions throughout, and there is no need to subdivide the project length.

Pavement condition ratings are to be carried out in the late spring and summer months to allow for the effects of frost heaving to dissipate, and for cracks widened by low temperature shrinkage to reclose.

Pavement condition ratings are needed at regular intervals so that management is aware of changing conditions and can plan maintenance and rehabilitation with

confidence. The completeness and uniformity of condition reports should lead to increased confidence in planning.

Pavement Distress Manifestation	Evaluation		
	Severity	Density	Other Characteristic
Surface Defects			
• Coarse Aggregate Loss			
• Ravelling			
• Flushing			
Surface Deformation			
• Rippling			
• Shoving			
• Wheel-Track Rutting			
• Distortion			
Cracking			
• Longitudinal Wheel Track			
• Mid-Lane			
• Centre Line			
• Pavement Edge			
• Meandering			
• Transverse			
• Alligator			
• Random			
• Slippage			
• Other			
Maintenance Patching			
• Spray			
• Skin (Cold- or Hot-Mix)			
• Hot/Cold-Mix Patch			
• Hot-Mix (Full-Width)			
• Crack Sealing			
• Crack Routed and Sealed			

Figure 1. List of Distress Manifestations

3. Procedure for Pavement Evaluation

Step 1

To assess Riding Comfort Rating, drive over the pavement at posted speed. This step will familiarize the rater with topography, special structures, etc. and will assist in establishing subsections to be rated individually from the work project. However, subsections must have a minimum length of 2 km.

Step 2

After establishing the subsections to observe distress, drive over the pavement in ONE direction at a maximum speed of 50 km/h for distress evaluation. Minimum one stop per section shall be made to examine distress type and severity, particularly surface conditions and surface deformation. More stops shall be made if condition is found to be varied (perhaps two or three stops per section).

If pavement exhibits essentially uniform conditions throughout, and there is no need to subdivide the work project, drive slowly (not exceeding 50 km/h) over pavement in ONE direction and make stops as necessary to examine type and severity (perhaps two stops per work project).

Step 3

Use the pavement distress manifestation classifications and the evaluation terminology, according to the Condition Rating Manual. It is strongly recommended that the distress manifestation checklist be used while in the field.

4. Riding Quality (Riding Comfort)

Riding quality of a pavement is the degree of riding comfort which the pavement section in question provides to the travelling public. To describe this riding quality, the evaluator should use the standard RTAC Present Performance Rating procedures. The rater drives over the pavement section at posted speed and, having done so, classifies the pavement's riding comfort according to the descriptions given in Table 1.

It is important that the rater should try not to be influenced by the appearance of the pavement surface when rating riding comfort; only the riding comfort the pavement provides to the rater should be considered relevant. It is also important that the rater should try not to be influenced by the pavement's class when rating riding comfort. The class of highways being rated should be considered irrelevant.

Table 1. Riding Comfort Rating Guide for Flexible Pavement

RCR*	Uniform Description of Riding Comfort at Posted Speed	Guidelines
10-8	Excellent	Smooth and pleasant ride
8-6	Good	Comfortable
6-4	Fair	Uncomfortable
4-2	Poor	Very rough and bumpy
2-0	Very poor	Dangerous at 80 km/h

*Note: Riding Comfort Rating (RCR) is a measure determined by a Panel of Raters or, alternatively, by measurement with a mechanical device which is correlated with a Panel of Raters.

5. Distress Manifestations

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5.1 Surface Defects 7

5.2 Distortion or Permanent Deformation 13

5.3 Cracking 20

Introduction

A distress in a pavement caused by vehicle loads or by material forces generated by changes in moisture, temperature, sunlight, and other environmental consequences, visibly manifests itself as a surface defect, as a distortion or pavement deformation, or as a crack.

Each type of distress manifestation named in this text is listed under one of three subgroups:

- **Surface Defects**
- **Distortion or Permanent Deformation**
- **Cracking**

Each defect is described and illustrated by one or more photographs. Possible causes of the defect are listed, and an example of the use of the uniform word description is presented.

To prepare a pavement condition report, the rater must first determine the extremities of each subsection within the project to be reported on, and within each subsection identify the types of distress manifestations present, and then evaluate the extent and severity of their occurrence. To aid the rater in this task, the Evaluation Form in Figure A-1 (Appendix A) is first consulted, and then the following sets of photographs (Figures 2 through 66) of distress manifestations are used to identify the types of distress present. Tables 2 through 18 give the uniform word descriptions for density and severity of occurrence of the different types of distress. Distress Manifestations (DM) is the sum of all types of distresses, weighted for density of occurrence and severity.

The Pavement Condition Rating (PCR) is the final result of the combined assessment of pavement riding quality and distress manifestations.

A more objective method of assessing the PCR value of a pavement section, which can use measured ride roughness and the word descriptions of pavement distress to calculate a numerical value known as The Distress Index (DI) is under development. Details of this development are presented in Appendix C.

Distress Manifestations

5.1 Surface Defects

Loss of Coarse Aggregates 7
Ravelling 9
Flushing 11

5.1 Surface Defects

Loss of Coarse Aggregates

Description: Coarse aggregate particles (>6 mm) are removed from the surface (Figure 2).

Possible Causes:

1. Lack of bond between particles and mortar due to inadequate coating or to stripping under the action of water.
2. Fracture of the particle through load or natural causes, allowing the loosened pieces to be picked out by traffic action.
3. Disintegration of particles such as chert which are highly absorptive and fracture and disintegrate upon repeated freezing and thawing.
4. Delamination of chert or shale particles.

Severity: See Table 2.

Density: See Table 3.

Example: Slight loss of coarse aggregate at intermittent intervals.

Possible Remedial Measures:

- Surface treatment or hot-mix resurfacing for severe or very severe conditions throughout.
- Spray patching for very severe but few or intermittent conditions.

Figure 2. Loss of Coarse Aggregates

Table 2. Guide for Describing Severity of Pavement Surface Distress — Loss of Coarse Aggregate

Class	Uniform Description	Guidelines (Based on observation of appearance)
1	Very slight	Barely noticeable
2	Slight	Noticeable
3	Moderate	Having pock-marked appearance; fairly well spaced between pock-marks.
4	Severe	Having pock-marked appearance; pock-marks are closely spaced.
5	Very severe	Surface has a ravelled appearance, and is disintegrated into small pot-holes.

Table 3. Guide for Describing Density of Pavement Surface Distresses

Class	Uniform Description	Guidelines (Based on percent of surface area in the pavement section being affected by defect)
1	Few	<10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

Ravelling

Description: Progressive loss of pavement material from surface downward or edge inward. This is sometimes called fretting (Figure 3).

Possible Causes:

1. Clay-coated aggregate particles.
2. Insufficient asphalt content.
3. Poor adhesion of asphalt binder to aggregate particles due to wet aggregate.
4. Poor compaction — especially cold weather paving — permits infiltration of water and salts which promote stripping of asphalt.
5. Asphalt hardening due to aging.

Severity: See Table 4.

Density: See Table 3.

Example: Slight ravelling at intermittent intervals in inner wheel track.

Possible Remedial Measures:

- Spray patching of severe or very severe localized condition.
- Hot-mix resurfacing of severe or very severe extensive condition.

Figure 3. Severe Ravelling

Table 4. Guide for Describing Severity of Pavement Surface Distress — Ravelling

Class	Uniform Description	Guidelines (Based on observation of appearance)
1	Very slight	Barely noticeable
2	Slight	Noticeable
3	Moderate	Open texture
4	Severe	Disintegration with small pot-holes
5	Very severe	Disintegration with large pot-holes

Flushing

Description: The presence of free asphalt binder on the surface resulting from upward migration of the binder. Most likely to occur in the wheel tracks during hot weather (Figures 4 and 5).

Possible Causes:

1. Too high asphalt content relative to void content in mineral aggregate. On the hot days, asphalt binder expands into air voids; if air voids are too low, continued expansion results in lower stability of the mix with the consequence that traffic will force out excess asphalt binder to the surface.
2. Paving over flushed surfaces. The excess asphalt on the old surface may be pumped up through the new paving over a period of time.
3. Paving over excess primed surfaces.

Severity: See Table 5.

Density: See Table 3.

Example: Moderate flushing intermittent in outer wheel tracks.

Possible Remedial Measures:

- Hot-mix resurfacing for extensive severe condition.
- Burn and chip seal for severe localized condition.

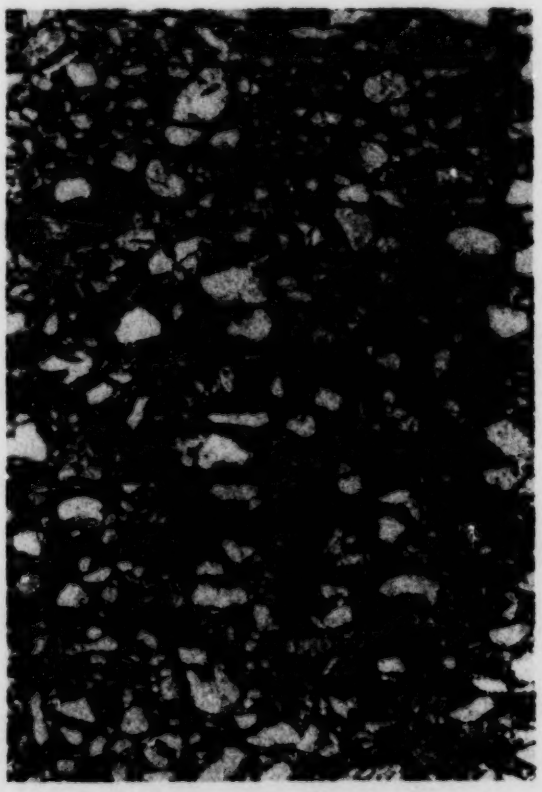


Figure 4. Slight Flushing

Figure 5. Severe Flushing

Table 5. Guide for Describing Severity of Pavement Surface Distress — Flushing

Class	Uniform Description	Guidelines (Based on observation of appearance)
1	Very slight	Very faint colouring (veining)
2	Slight	Colouring visible (interconnected veining)
3	Moderate	Distinctive appearance (with excessive asphaltic materials already free).
4	Severe	Free asphaltic materials giving the pavement surface area a wet look.
5	Very severe	Free asphaltic materials giving the affected pavement surface area a wet look and wheel noise comparable to that when driving over a water-wet surface.

Table 5. Guide for Describing Severity of Pavement Surface Distress — Flushing

Class	Uniform Description	Guidelines (Based on observation of appearance)
1	Very slight	Very faint colouring (veining)
2	Slight	Colouring visible (interconnected veining)
3	Moderate	Distinctive appearance (with excessive asphaltic materials already free).
4	Severe	Free asphaltic materials giving the pavement surface area a wet look.
5	Very severe	Free asphaltic materials giving the affected pavement surface area a wet look and wheel noise comparable to that when driving over a water-wet surface.

Distress Manifestations

5.2 Distortion or Permanent Deformation

Rippling 13
Shoving 15
Rutting 16
Distortion 18

5.2 Distortion or Permanent Deformation

Rippling

Description: Regular transverse undulations in the surface of the pavement consisting of closely-spaced, alternate valleys and crests. Considered due to faulty paver behaviour with some mixes. Generally results in a rough ride and becomes worse with time (Figure 6).

Possible Causes:

1. Faulty paver behaviour with some mixes.
2. Heavy traffic on steep downgrade or upgrade, or pavement with too thick tack coat or too thick soft waterproofing membranes on bridge decks.
3. Low stability in asphalt mix.
4. Stopping at intersection stop lights.

Severity: See Table 6.

Density: See Table 7.

Example: Severe rippling occurring frequently across the surface.

Possible Remedial Measures:

- Cold planing of severe extensive condition with hot-mix resurfacing.
- Cold planing, heater planing or cold/hot-mix patching of severe localized condition.

Figure 6. Severe Rippling

Table 6. Guide for Describing Severity of Pavement Distresses — Rippling or Shoving

Class	Uniform Description	Guidelines (Based on observation of appearance)
1	Very slight	Barely noticeable
2	Slight	Noticeable
3	Moderate	Rough ride
4	Severe	Very rough ride
5	Very severe	Vehicle may lose control because of its presence.

Table 7. Guide for Describing Density of Pavement Distresses — Rippling or Shoving

Class	Uniform Description	Guidelines (Based on observation of appearance)
1	Few	<10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

Shoving

Description: The asphalt surfacing is very uneven as a result of traffic moving it away from the wheel tracks, or forward or backwards in the wheel track (Figure 7).

Possible Causes:

1. Low stablility mix.
2. Lack of bond between asphalt surface and underlying layer — may be caused by excess tack coat acting as a lubricant.
3. Unstable granular base reflecting through the surface.
4. Stop and start of vehicles at intersections.

Severity: See Table 6.

Density: See Table 7.

Example: Moderate shoving at a few locations.

Possible Remedial Measures: See rippling.

Figure 7. Shoving (Caused by Horizontal Thrust of Wheels)

Rutting

Description: Longitudinal depressions left in the wheel tracks after repeated load repetitions. It results from compaction under the load combined with a shoving sideways of pavement material (Figure 8).

Possible Causes:

1. Poorly-compacted structural layers.
2. Unstable granular bases or subbases created by positive pore water pressures under loads at times of near saturation.
3. Unstable asphalt mixes (due to high temperature or low viscosity of binder).
4. Unstable shoulder material; does not provide adequate lateral support.
5. Overstressed subgrade will deform permanently.

Severity: See Table 8. Rutting is measured on a 1.2-m wide base, the same as used at the AASHTO Road Test.

Density: See Table 9.

Example: Severe rutting throughout the section.

Possible Remedial Measures:

- Cold- or hot-mix patching of severe localized condition.
- Paving and hot-mix resurfacing for severe extensive condition.

Figure 8. Very Severe Rutting

Table 8. Guide for Describing Severity of Pavement Wheel-Track Rutting

Class	Uniform Description	Guidelines (Based on appearance and rut-depth measured with a standard 1.2-m gage)
1	Very slight	Barely noticeable (6 mm)
2	Slight	6 mm - 13 mm
3	Moderate	13 mm - 19 mm (may include slight longitudinal cracks)
4	Severe	19 mm - 50 mm (may include multiple longitudinal cracks)
5	Very severe	50 mm (may include multiple longitudinal cracks or alligator cracks)

Table 9. Guide for Describing Density of Pavement Wheel-Track Rutting

Class	Uniform Description	Guidelines (Based on percent of total wheel-track length in pavement section affected by defect)
1	Few	<10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

Distortion

Description:

Any deviation of the pavement surface from its original shape other than described for rippling, shoving, and rutting. Generally, distortions result from settlement, slope failure, volume changes due to moisture changes and to frost heaving, and from residual effects of frost heaving accumulating after each season.

Distortion may take the form of dishing, bumps, dips, tenting or stepping at cracks, all of which give rise to pitch and roll in a moving vehicle (Figures 9 and 10).

Possible Causes:

1. Differential frost heave in poorly-drained cuts and transitions.
2. Differential frost heave at pavement edges or road centre.
3. Reverse differential frost heave at culverts.
4. Differential settlement of subgrade or base materials.
5. Lack of subgrade support.
6. Embankment slope failure.

Severity:

See Table 10. Severity of distortion is assessed by raters in a subjective manner based on the relative motion of a moving vehicle over the paved surface. Distortion causes the vehicle to pitch and roll, and the rater must evaluate the severity on the basis of his past experience. The guidelines in the table are intended to assist in developing uniformity in assessment of this defect.

Density:

See Table 11.

Example:

Severe distortion occurs extensively in the section.

Possible Remedial Measures:

- Cold- or hot-mix patching of severe localized condition.
- Excavation and removal of unsuitable materials and hot-mix patching for very severe localized condition.
- Hot-mix patching with hot-mix resurfacing for extensive severe condition.

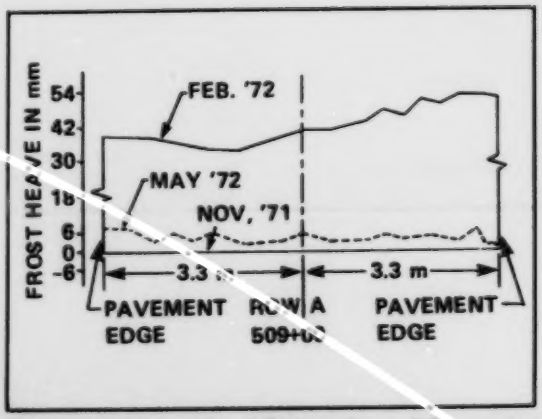


Figure 9. Example of Distortion of Pavement Edges Due to Frost Heave

Figure 10. Very Severe Distortion

Table 10. Guide for Describing Severity of Pavement Distortion

Class	Uniform Description	Guidelines (Based on personal experience of the interaction between vehicle and pavement surface distortion)
1	Very slight	Noticeable (swaying motion).
2	Slight	Good control of car still present for driver of vehicle.
3	Moderate	Fair control of car when driving over pavement.
4	Severe	Poor car control when driving over pavement with driver always having to anticipate distortion ahead.
5	Very severe	Continuous distortion making it a dangerous situation if driving car at speed greater than 60 km/h.

Table 11. Guide for Describing Density of Pavement Distortion

Class	Uniform Description	Guidelines (Based on percent of pavement length in section affected by defect)
1	Few	<10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

Distress Manifestations

5.3 Cracking

Longitudinal Wheel-Track Cracking 20
Longitudinal Mid-Lane Crack 24
Centre Line Crack 25
Meandering Crack 27
Pavement Edge Crack 28
Transverse Crack 33
Random Crack 36
Alligator Crack 38
Slippage Crack 42
Miscellaneous 43

5.3 Cracking

Longitudinal Wheel-Track Cracking

Description: Cracks which follow a course approximately parallel to the centre line of the pavement and are situated at or near the centre of the wheel tracks (Figures 11, 12, 13 and 14).

Possible Causes: Due to overloaded vehicles at the weakest pavement period in the early spring. Fatigue failure of thin asphalt surfacings are initiated in this manner.

Severity: See Table 12. There are two elements of crack severity which must be evaluated: first is the multiplicity of the cracking; second is the crack opening. Multiplicity is categorized as:

- single — one continuous crack over a considerable length,
- multiple — two or more cracks closely spaced and parallel to each other, or
- alligator — two or more cracks closely spaced and interwoven with each other giving the appearance of loosely-braided strands of rope or of alligator skin. (A detailed description of alligator cracking is given on Pages 38 to 41.)

Crack opening is described in Table 12 and illustrated in Figures 15, 16, 17, 18 and 19.

Density: See Table 13.

Example: Slight multiple longitudinal wheel-track cracking occurs intermittently over section.

Possible Remedial Measures:

- Rout and seal with approved sealant when single, slight and extensive.
- Cold- or hot-mix patching for alligator condition.

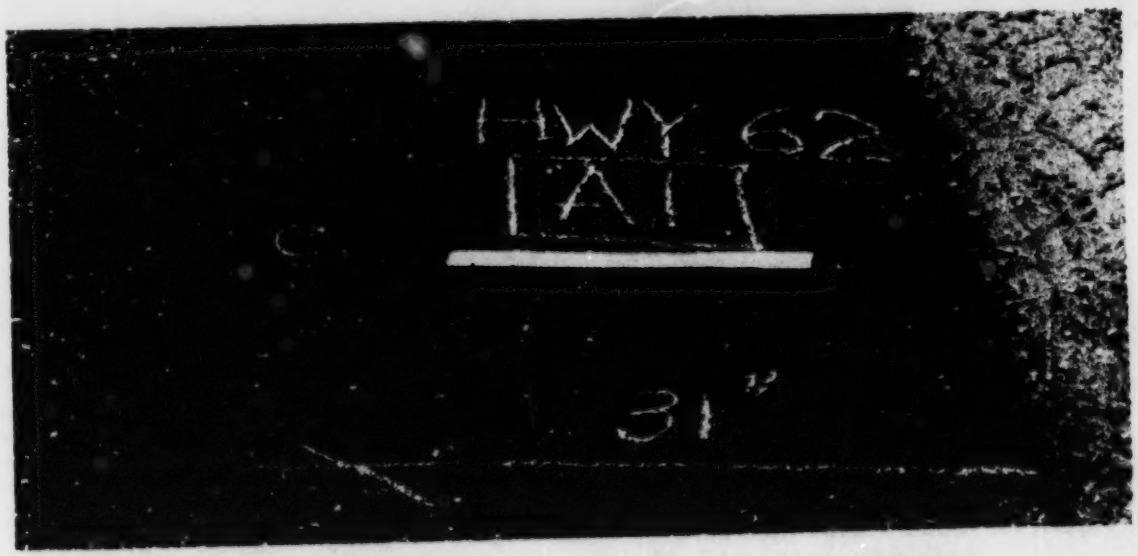


Figure 11. Slight Single Longitudinal Outer Wheel-Track Crack

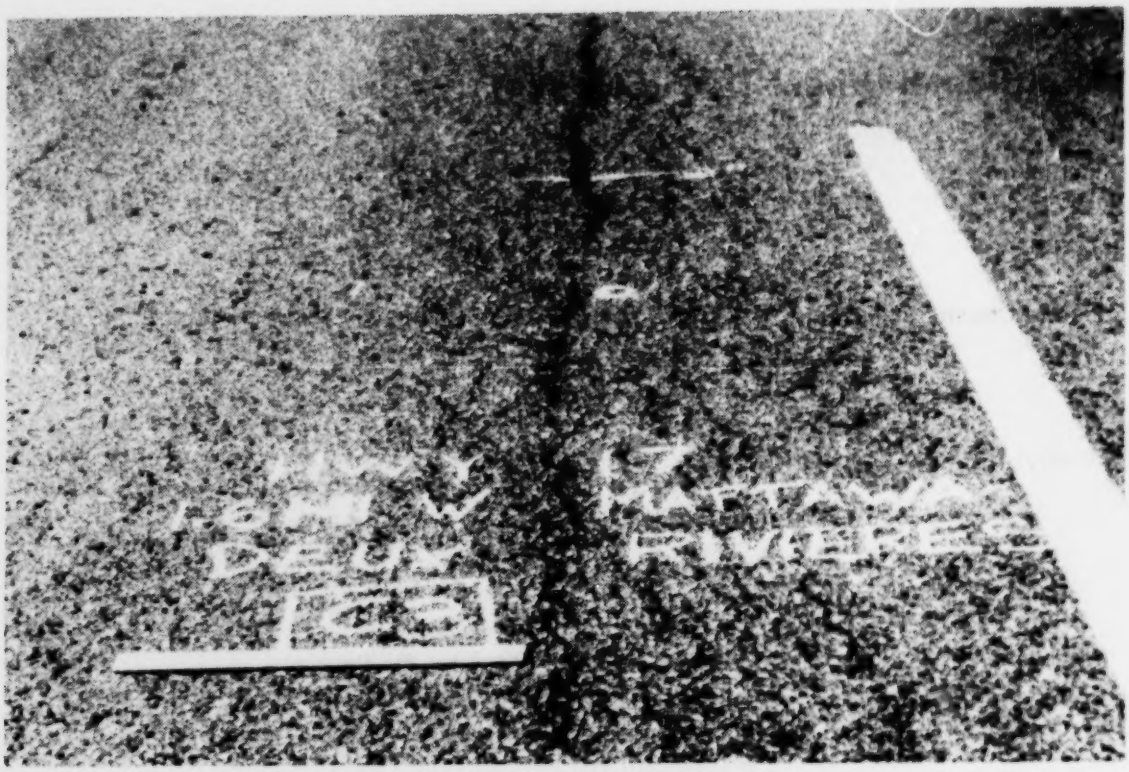


Figure 12. Moderate Multiple Longitundinal Inner Wheel-Track Crack

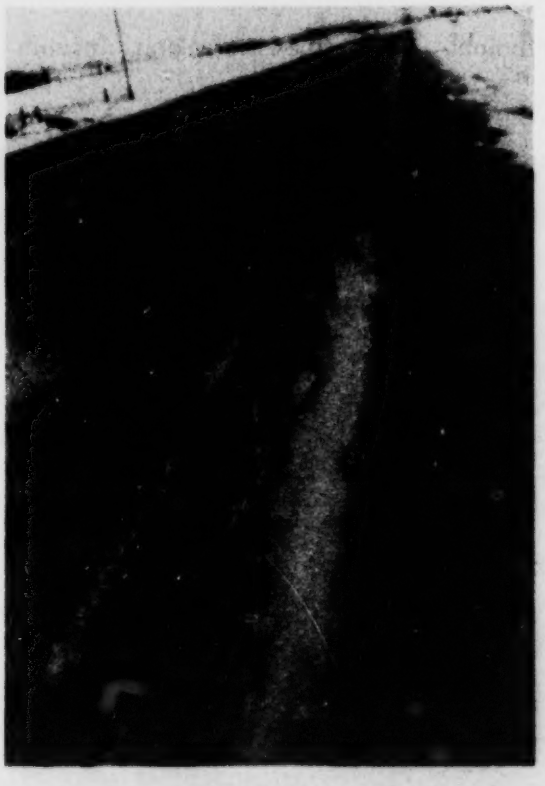


Figure 13. Moderate Multiple Longitudinal Outer Wheel-Track Crack

Figure 14. Longitudinal Outer Wheel-Track Crack Progresses into Moderate Alligator Crack

Table 12. Guide for Describing Severity of Pavement Cracking — Longitudinal Cracks

Class	Uniform Description	Guidelines (Based on crack width and its condition)	Figure
1	Very slight	≤ 2 mm (≤ 1/16")	15
2	Slight	6 mm - 13 mm (¼" - ½")	16
3	Moderate	13 mm - 19 mm (½" - ¾")(single or multiple longitudinal cracks)	17
4	Severe	19 mm - 25 mm (¾" - 1") (with spalling beginning to develop.) Multiple parallel longitudinal cracks also begin to develop alongside the original crack in very slight (2 mm) to slight (6 mm) crack width.	18
5	Very severe	>25 mm (>1") (with spalling developed). Slight to moderate multiple parallel longitudinal cracks also developed alongside the original crack may even begin to alligator. (Refer to Pages 38 to 41 for a description of alligator cracking).	19

Table 13. Guide for Describing Density of Pavement Cracking — Longitudinal Cracks

Class	Uniform Description	Guidelines (Based on percent of total length in the pavement section affected by the defect)
1	Few	<10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

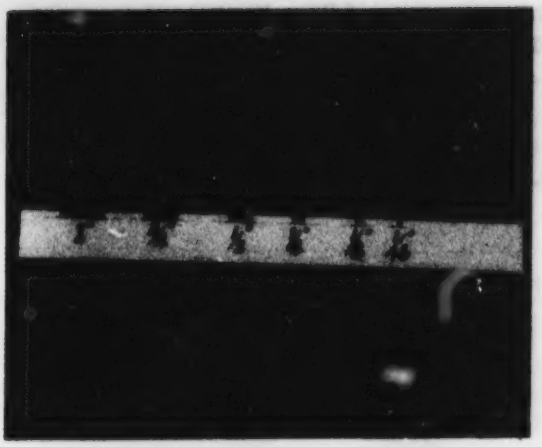


Figure 15. Very Slight Crack
(Class 1, Table 12)

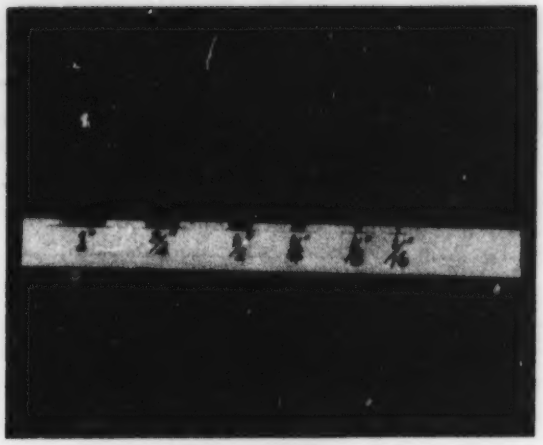


Figure 16. Slight Crack
(Class 2, Table 12)

Figure 17. Moderate Crack
(Class 3,Table 12)

Figure 18. Severe Crack
(Class 4, Table 12)

Figure 19. Very Severe Crack
(Class 5, Table 12)

Longitudinal Mid-Lane Crack

Description: Crack which is usually straight and parallel to the centre line situated at or near the middle of the lane (Figure 20). This crack is usually a single crack, but occasionally secondary cracks do develop parallel to it (Figure 21).

Possible Causes: Faulty construction equipment appears to result in weak plane which then fails, due to thermal shrinkage.

Severity: See Table 12.

Density: See Table 13.

Example: Severe longitudinal mid-lane cracking occurs extensively in section.

Possible Remedial Measures:
- Rout and seal with approved sealant when extensive and slight.
- Hot- or cold-mix patching if very severe and of localized condition.

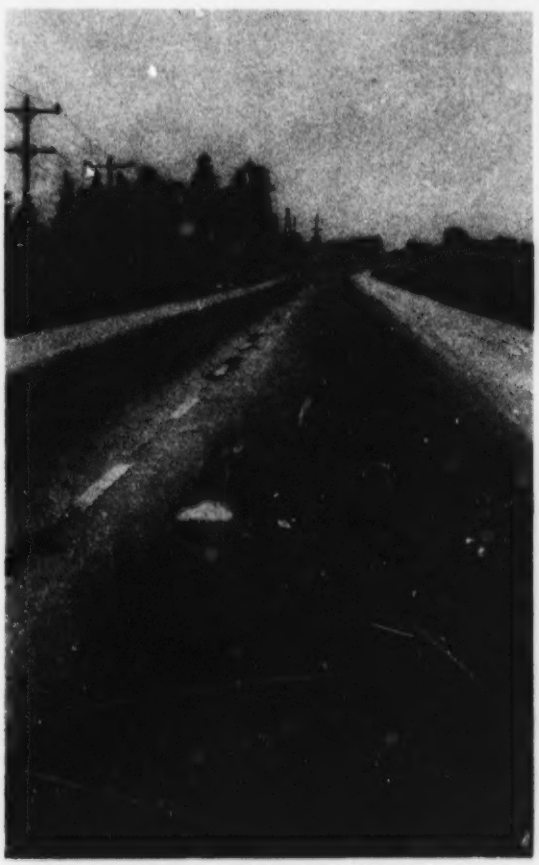


Figure 20. Longitudinal Mid-Lane Crack

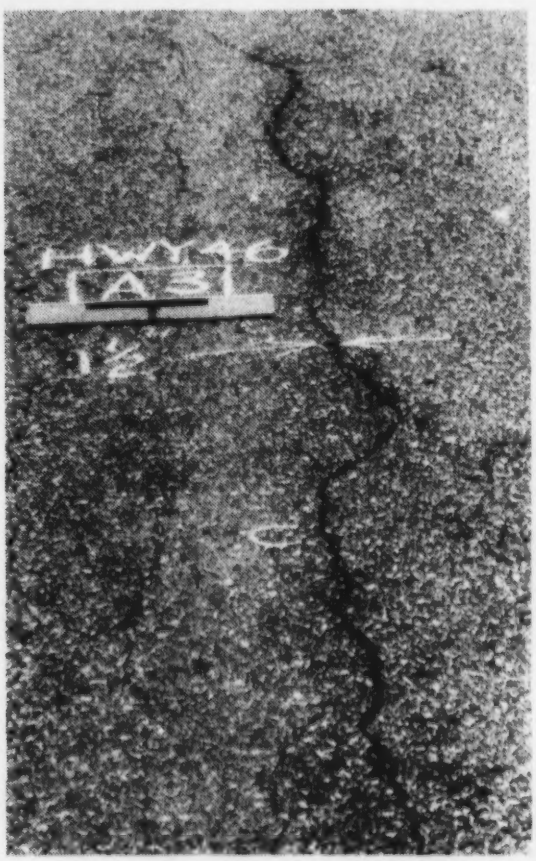


Figure 21. Multiple Longitudinal Mid-Lane Crack

Centre Line Crack

Description: Crack(s) which runs along or in the immediately adjacent vicinity of the road centre line (Figures 22, 23, 24 and 25).

Possible Causes:

1. Poor longitudinal joint construction.
2. Frost action — variable granular depths due to constructing lanes separately; differential frost heave along centre line due to insulating value of snow along pavement edges.
3. Moisture changes (swelling/shrinkage).

Severity: See Table 12.

Density: See Table 13.

Example: Moderate alligator centre line crack occurs frequently over section length.

Possible Remedial Measures:

- See longitudinal mid-lane crack.

Examples of Poor Joint Construction

Figure 22. Centre Line Crack

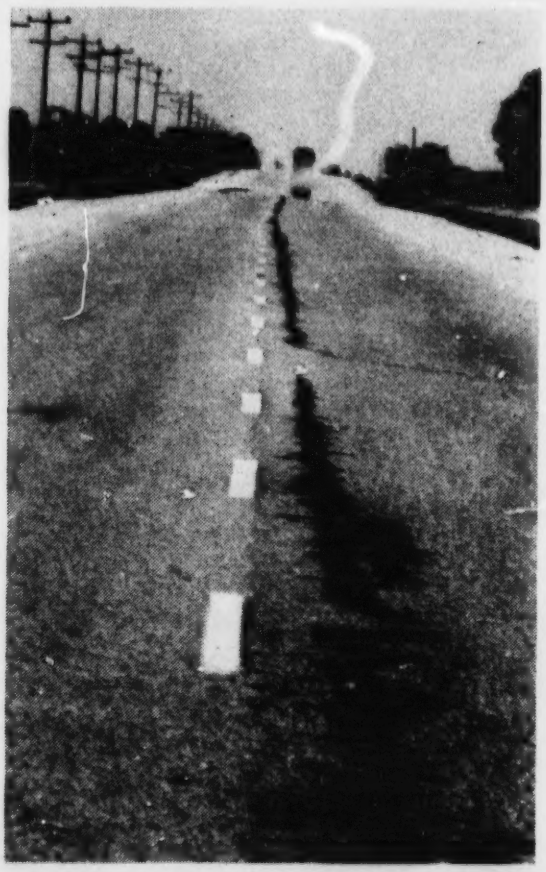


Figure 23. Centre Line Crack (at Centre Joint)

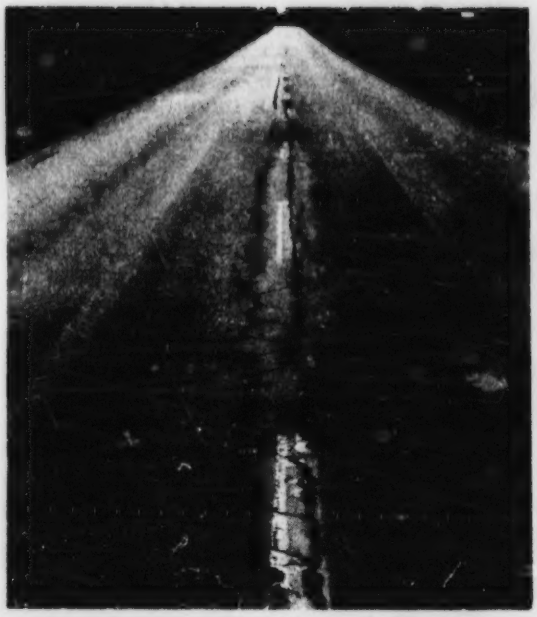


Figure 24. Multiple Centre Line Crack

Figure 25. Alligator Centre Line Crack

Meandering Crack

Description: Crack which wanders from edge to edge of the pavement, usually of quite long lengths. Mostly single, but secondary cracks do develop (Figures 26 and 27).

Possible Causes:
1. Frost action — greater heave at pavement centre than at edges. More prevalent in mixes where asphalt stripping is extensive.
2. Poor construction practises.

Severity: See Table 12.

Density: See Table 13.

Example: Moderate multiple meandering crack occurs intermittently in section.

Possible Remedial Measures: - See longitudinal mid-lane crack.

Figure 26. Meandering Crack

Figure 27. Multiple Meandering Crack

Pavement Edge Crack

Description: Crack(s) which is parallel to and within 30 cm of the pavement edge and is either a fairly continuous "straight" crack as in Figure 28, or consists of crescent-shaped cracks in a wave formation as in Figure 29. On some thin asphalt surfaces in southwestern Ontario, pavement edge cracking progressively encroaches into the outer wheel tracks through the middle of the lane, and may even progress right across to the centre line. This is illustrated in Figures 30, 31, 32, 33 and 34.

Possible Causes:

1. Frost action.
2. Insufficient bearing support and/or excessive traffic loading at the pavement edge.
3. Poor drainage at pavement edge and shoulder.
4. Inadequate pavement width forces traffic too close to pavement edge.

Severity: See Table 14. This is based on multiplicity and extent of progression. Each stage of increasing severity is illustrated in Figures 35 through 41.

Density: See Table 13.

Example: Very severe edge cracking throughout the section.

Possible Remedial Measures:

- Improved shoulder drainage or seal shoulder from water.
- Spray patching of slight to moderate condition.
- Cold-mix patching of slight to severe condition.
- Hot-mix patching of severe to very severe condition.

Figure 28. Pavement Edge Crack (Longitudinal Formation)

Figure 29. Pavement Edge Crack (Wave Formation)

Figure 30. Single Wave Pavement Edge Crack (Stage 1)

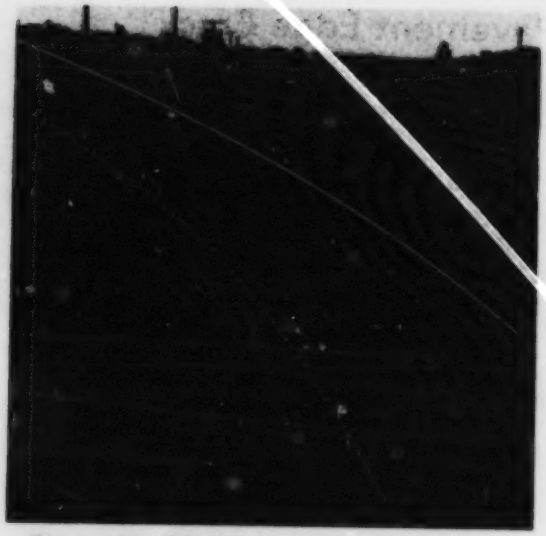


Figure 31. Multiple Wave Pavement Edge Crack (Stage 2)

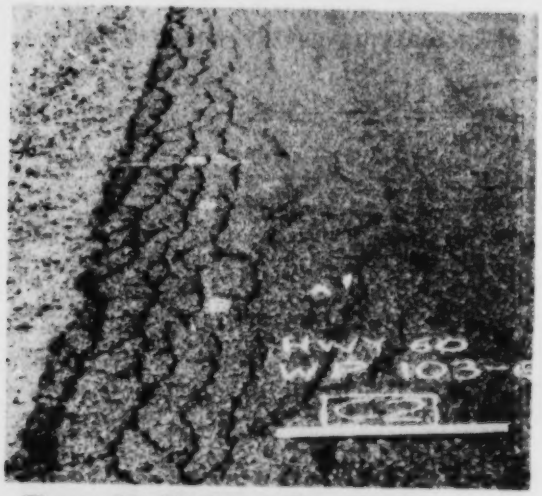


Figure 32. Moderate Progressive Edge Cracking (Stage 3)

Figure 33. Very Severe Progressive Edge Cracking (Stage 4)

Figure 34. Very Severe Progressive Edge Cracking (Stage 5)

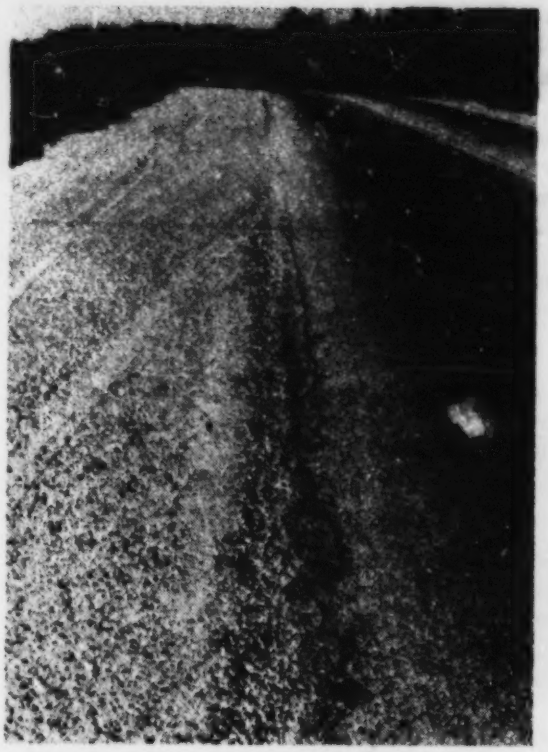


Figure 35. Very Slight Pavement Edge Crack (Class 1, Table 14)

Figure 36. Very Slight Pavement Edge Crack (Class 1, Table 14)

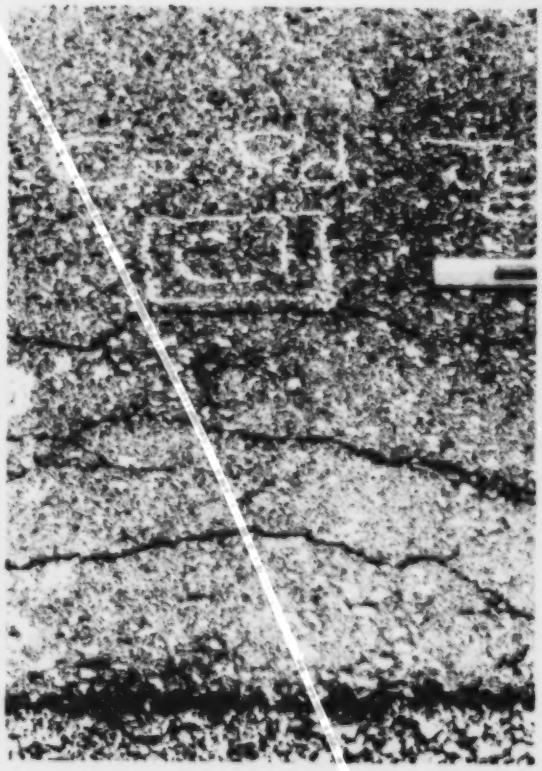


Figure 37. Slight Multiple Pavement Edge Crack (Class 2, Table 14)

Figure 38. Slight Multiple Pavement Edge Crack (Class 2, Table 14)

Table 14. Guide for Describing Severity of Progressive Pavement Edge Cracking

Class	Uniform Description	Guidelines* (Based on multiplicity and stage of development)	Figure
1	Very slight	Single longitudinal formation or single wave-formation.	35/36
2	Slight	Multiple parallel longitudinal formation or wave-formation under 0.6 m from pavement edge.	37/38
3	Moderate	Progressive multiple cracks extend over 0.6 m but under 1 m from pavement edge. Cracks begin to braid (interweave).	39
4	Severe	Progressive multiple cracks extend over I m but under 2.5 m from pavement edge. Outermost area near edge begins to alligator.	40
5	Very severe	Progressive multiple cracks extend over 1.5 m from pavement edge. Outermost area near edge is alligatored; mid-portion and innermost portion show multiple cracking (or alligatoring).	41

* The above guide is used for describing progressive pavement edge cracking which is generally found in southwestern Ontario. For pavement edge cracking which does not progress any further than 300 mm from the pavement edge, severity description should be the same as in Table 12. However, its non-progressive characteristic should be duly noted.

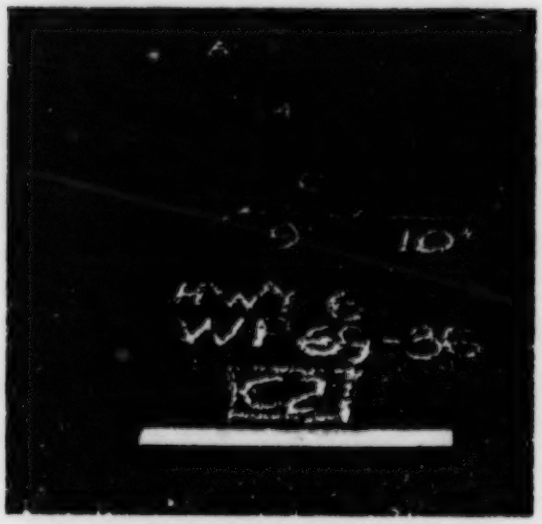


Figure 39. Moderate Progressive Pavement Edge Crack (Class 3, Table 14)

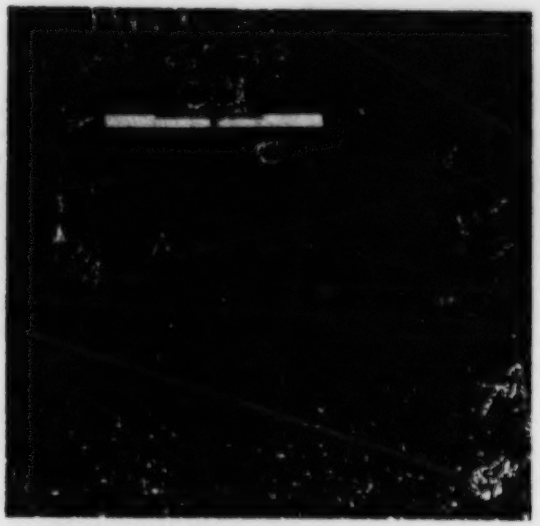


Figure 40. Severe Progressive Pavement Edge Crack (Class 4, Table 14)

Figure 41. Very Severe Progressive Pavement Edge Crack (Class 5, Table 14)

Transverse Crack

Description: Crack which follows a course approximately at right angles to the pavement centre line (Figures 42, 43 and 44). Full transverse cracks tend to be regularly spaced along the length of the road, while half transverse and part transverse occur at shorter intermediate distances.

Possible Causes:

1. Natural shrinkage caused by very low temperatures.
2. High temperature susceptibility of asphalt cement binder in asphalt mixes.
3. Frost action.
4. Reflection cracks.

Severity: See Table 15. Transverse cracks are further subdivided into full (across both lanes of two-lane road), half (across only one lane), and partial (across less than three-quarters lane width). See Figures 45, 46 and 47.

Density: See Table 16.

Example: Slight transverse cracks at a few locations in the section. Crack spacing is 30 m. The majority are full; only some are partial.

Possible Remedial Measures:

- Rout and seal if slight and extensive.
- Cold- or hot-mix patching if alligator in localized condition.

Figure 42. Transverse Crack

Figure 43. Transverse Crack

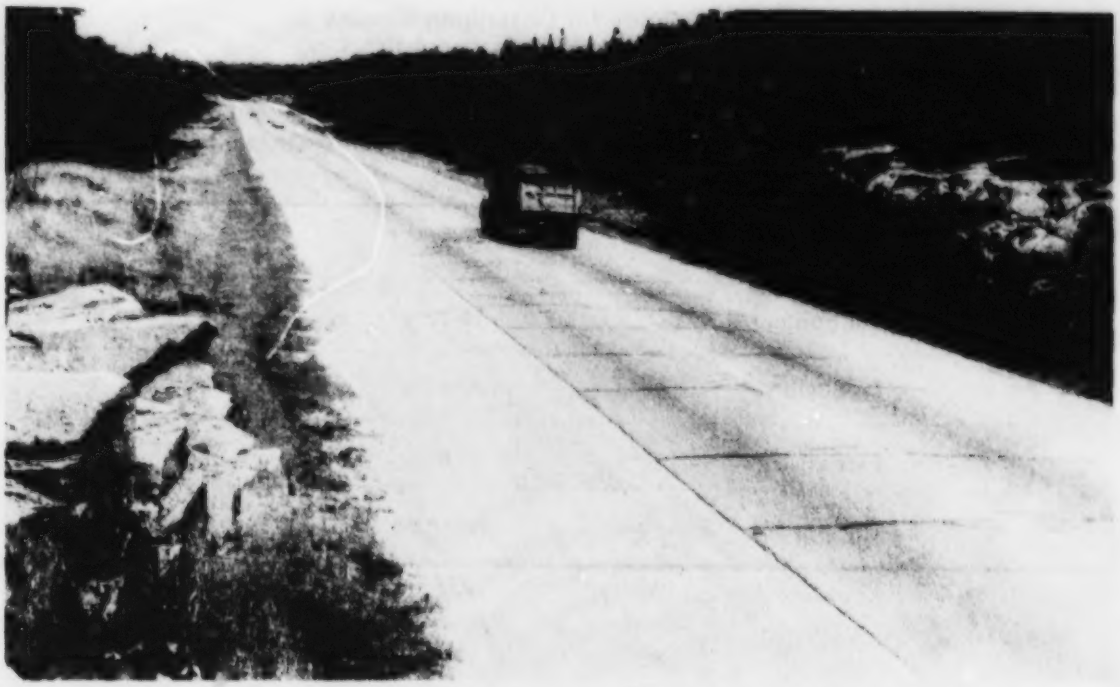


Figure 44. Typical Transverse Crack Regularly Spaced along the Length of the Roadway

Table 15. Guide for Describing Severity of Pavement Transverse Cracking

Class	Uniform Description	Guidelines* (Based on crack width, condition and multiplicity)
1	Very slight	2 mm (partial and singular)
2	Slight	6 mm - 13 mm (full and singular)
3	Moderate	13 mm - 19 mm (Multiple cracking begins to develop.)
4	Severe	19 mm - 25 mm (with spalling, stepping or lipping beginning to develop in singular or multiple cracks).
5	Very severe	>25 mm (with spalling, stepping or lipping in multiple cracks which are beginning to develop into alligator cracking). (Refer to Pages 38 to 41 for a description of alligator cracking.)

* In describing the severity of transverse cracking, the characteristics of the transverse cracks must also be described in terms of spacing between the cracks. Actual distance estimated to the nearest metre should be used, for example, "very slight transverse cracks spaced 3 m apart."

Table 16. Guide for Describing Density of Pavement Transverse Cracking

Class	Uniform Description	Guidelines (Based on percent of total pavement surface area in the pavement section affected by defect)
1	Few	<10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

Figure 45. Full Multiple Transverse Crack

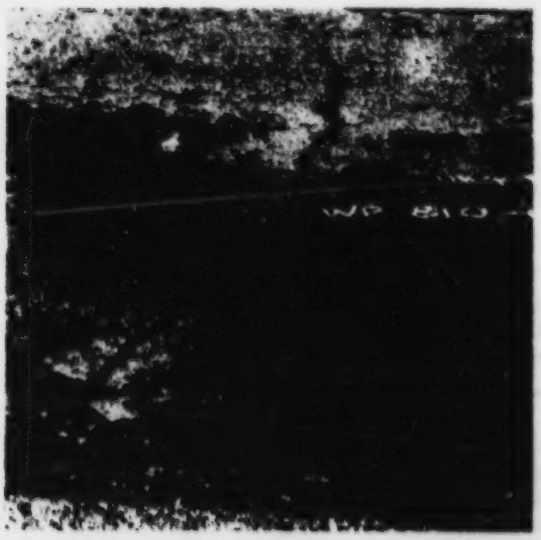


Figure 46. Half Transverse Crack

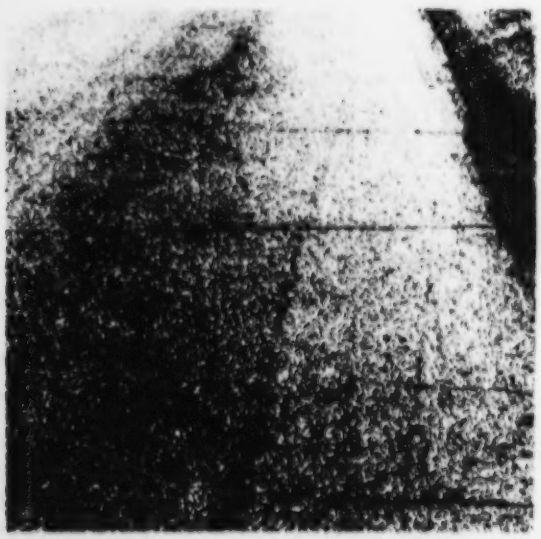


Figure 47. Partial Transverse Crack

Random Crack

Description: Crack which runs randomly across and along the surface sometimes in a serpentine manner. The crack appears to have transverse and longitudinal cracks combined (sometimes called map cracking) (Figures 48, 49 and 50).

Possible Causes:
1. Swelling or shrinkage.
2. Frost action.

Severity: See Table 12.

Density: See Table 13.

Example: Moderate random cracking of intermittent occurrence in the section.

Possible Remedial Measures:
- Hot-mix resurfacing.

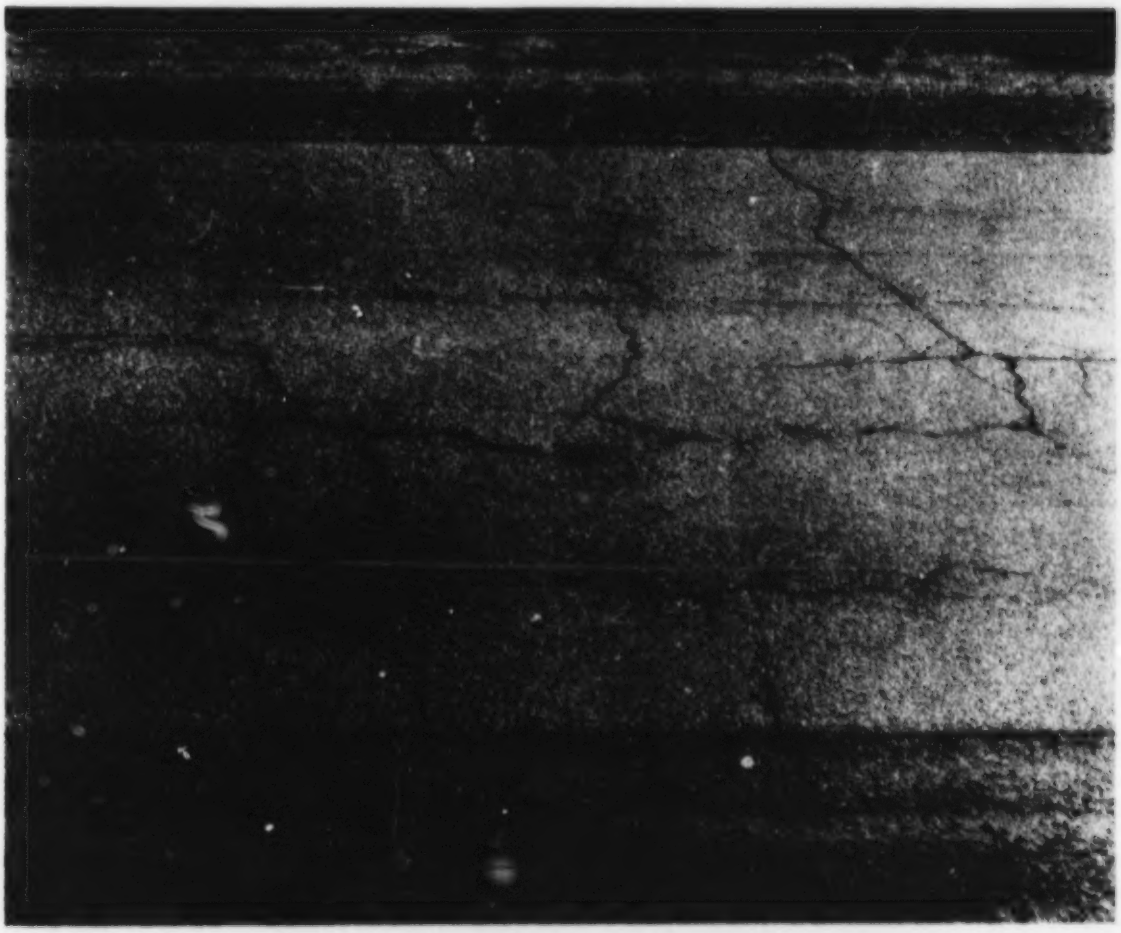


Figure 48. Random Crack
(This formation is sometimes called "map crack.")

Figure 49. Random Crack

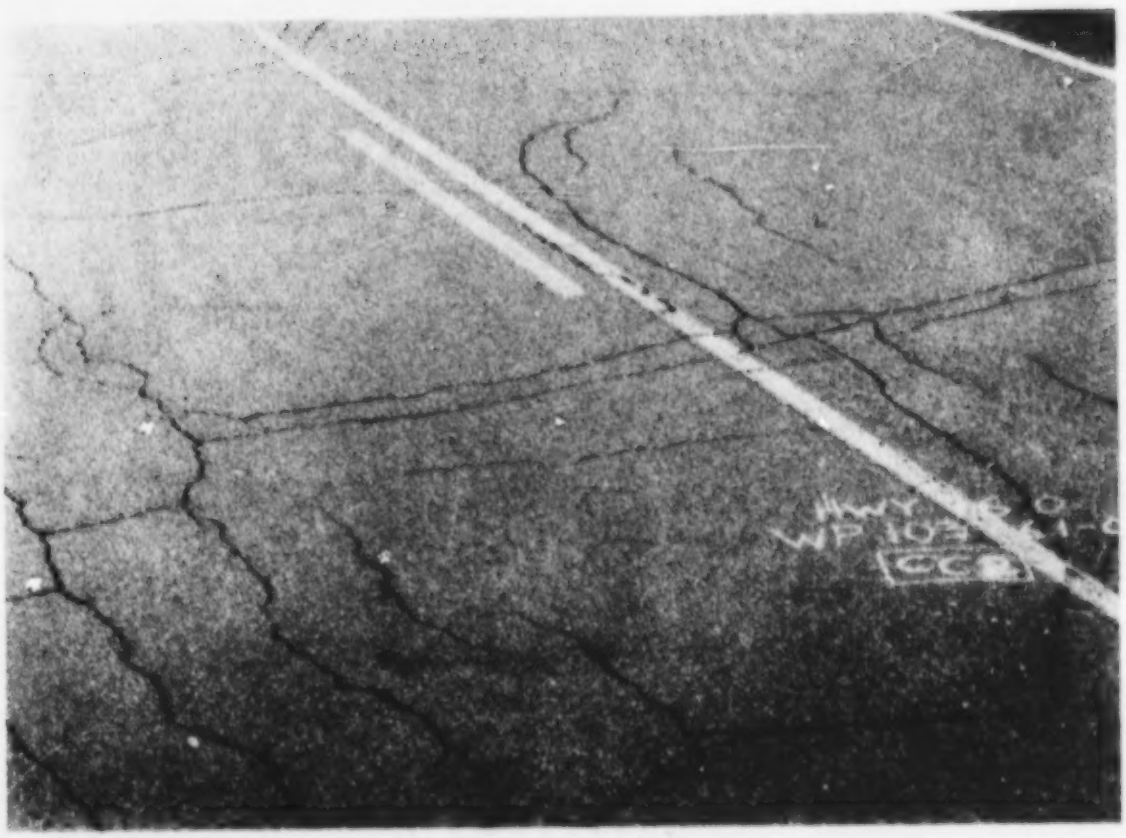


Figure 50. Random Crack

Alligator Crack

Description:

Cracks which form a network of multi-sided (polygon) blocks resembling the skin of an alligator. The block size can range from a few millimetres to about a metre. The block size is indicative of the level (depth) at which failure is taking place. The small block sizes, 100 mm to 150 mm, indicate that movement is occurring in the upper (granular base) layer. This type of alligatoring is mostly observed on "thin" (less than 75 mm) asphalt surfacings, accompanied at times by slight depressions (perhaps 12 mm) (Figures 51, 52 and 53). The large block sizes, 300 mm and more, indicate that movement is occurring in the deeper layers and subgrade. This type of alligatoring is accompanied by large depressions (perhaps as much as 50 mm) together with a lateral movement outwards (and upwards) of the pavement edge; it forms a "bird-bath" during rains (Figures 54 and 55).

Alligatoring is a consequence of the inability of a part of the structure to support the repeated loads due to a "softening" of the material. "Softening" is normally associated with an increase in moisture content.

Alligator failures which are deep-seated in the subbase or subgrade are progressive, i.e., under traffic, and rains, they tend to spread rapidly, and traffic causes blocks of surfacing to be displaced and broken up. The only successful remedial treatment is the removal of all softened material in the affected area and replacement with sound granular material. Alligator failures which are in the upper layers, normally appear in the very early spring. They do not generally progress after warmer weather first appears, probably because drainage of the wet granular bases has increased its strength.

Possible Causes:

1. Insufficient bearing support.
2. Poor base drainage and stiff or brittle asphalt mixes at cold temperatures.

Severity:

See Table 17. Figures 56, 57, 58 and 59 are used to illustrate the different levels of severity.

Density:

See Table 18.

Example:

Moderate alligator cracking occurs frequently in outer wheel track.

Possible Remedial Measures:

- Cold- or hot-mix patching of severe and localized condition.
- Excavation and recycled hot-mix patching of severe and localized condition.
- Excavate to granular grade and replaced with hot-mix resurfacing for severe and localized condition.
- Reconstruction, if severe and extensive.

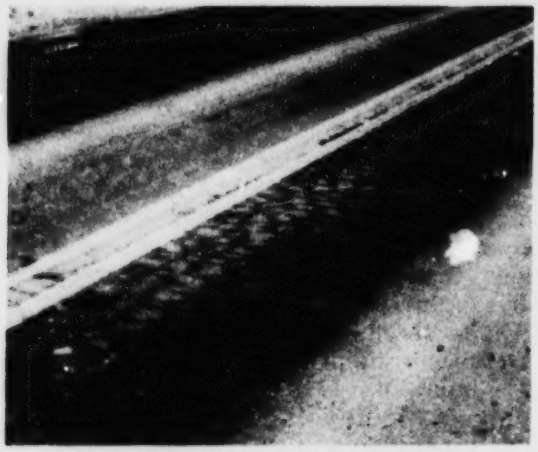


Figure 51. Alligator Crack

Figure 52. Alligator Crack

[Result of movement occurring in the upper (granular base) layer]

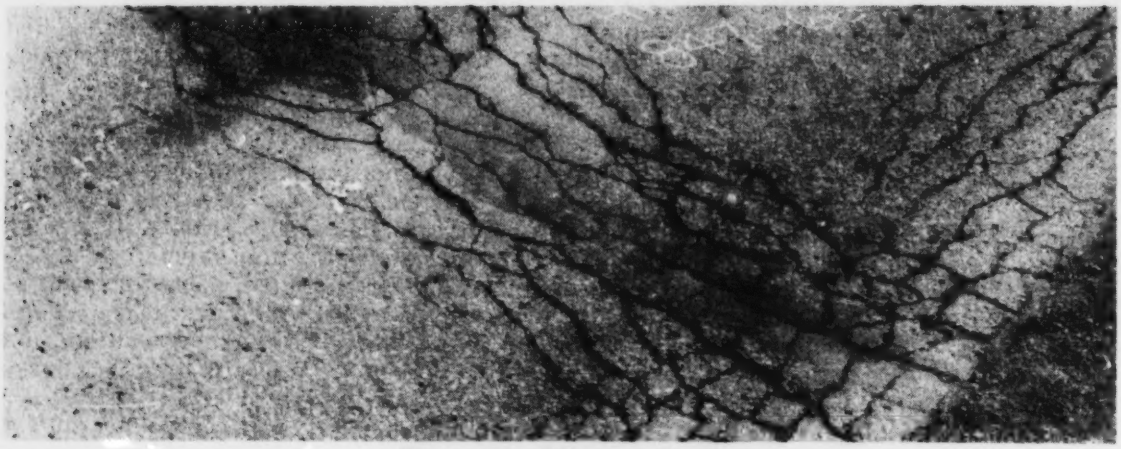


Figure 53. Alligator Crack

[Result of movement occurring in the upper (granular base) layer]

Figure 54. Alligator Crack

Figure 55. Alligator Crack

(Result of movement occurring in the deeper layers and subgrade)

Table 17. Guide for Describing Severity of Pavement Alligator Cracking

Class	Uniform Description	Guidelines* (Based on appearance and surface distortion)	Figure
1	Very slight	Alligator pattern just formed; distortion less than 12 mm.	
2	Slight	Alligator pattern established with corners of polygon blocks fracturing; distortion 13 mm plus.	56
3	Moderate	Alligator pattern established with spalling of polygon blocks; distortion 13 mm plus.	57
4	Severe	Polygon blocks begin to lift; distortion 25 mm plus. Patching required.	58
5	Very severe	Complete disintegration of affected area; pot-holes from missing blocks; over 50 mm distortion. Immediate repair required.	59

* In describing the severity of alligator cracking, the characteristics of the alligator crack must also be described in terms of block size. Actual dimensions estimated to the nearest millimetre should be used, for example, "moderate alligator cracking with block size approximately 150 mm overall."

Table 18. Guide for Describing Density of Pavement Alligator Cracking

Class	Uniform Description	Guidelines (Based on percent of surface area of pavement section affected by defect)
1	Few	<10%
2	Intermittent	10-20%
3	Frequent	20-50%
4	Extensive	50-80%
5	Throughout	80-100%

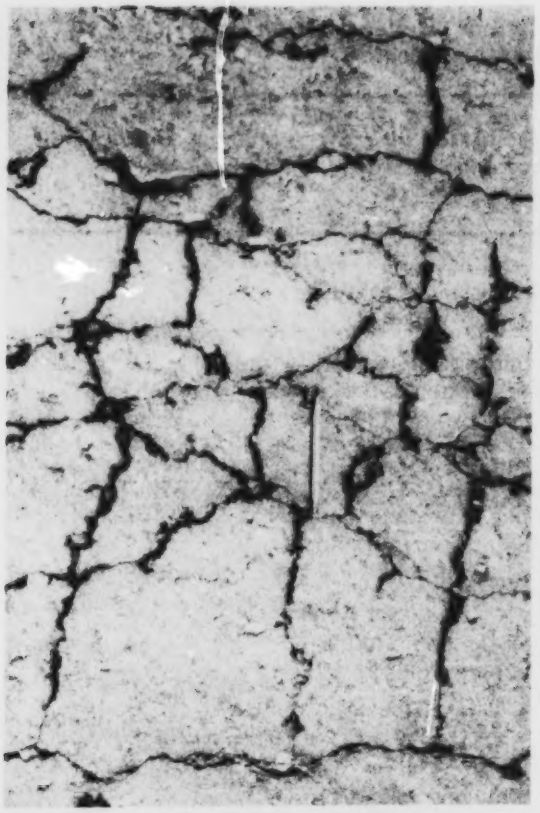


Figure 56. Moderate Alligator Crack

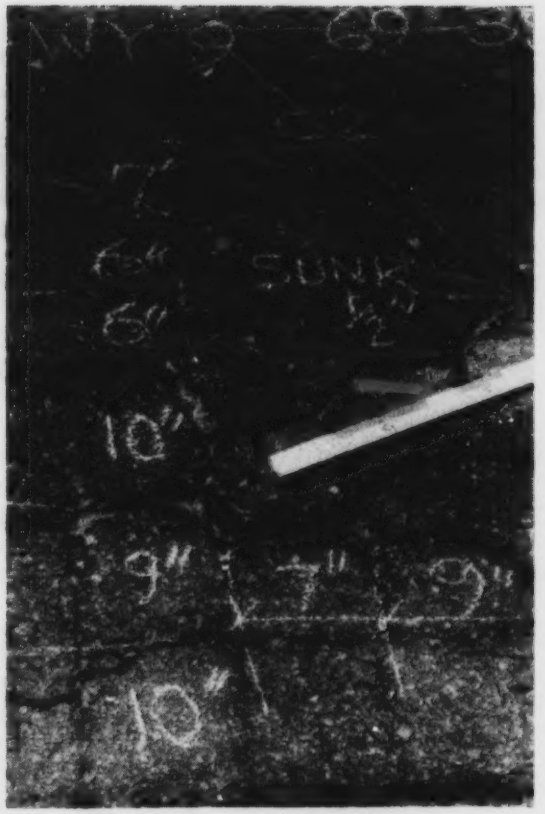


Figure 57. Severe Alligator Crack

Figure 58. Severe Alligator Crack

Figure 59. Very Severe Alligator Crack

Slippage Crack

Description: Crack which outlines the edge of a fill settlement. Generally takes the form of a large crescent. The enclosed side of the crescent is depressed, or may have been filled in with surfacing material (Figure 60).

Possible Causes: Embankment slope slip failure.

Severity: See Table 12.

Density: See Table 13.

Example: Severe settlement crack in a few locations in the section.

Possible Remedial Measures:
- Cold- or hot-mix patching.
- Excavate and replace with granular and hot-mix patching.
- Reconstruction, if severe and extensive.

Figure 60. Slippage Crack

Miscellaneous

There are other cracks which are not specifically described in the above subsections because they are either uncommon or are restricted to local areas. In all cases of reporting such cracks, the crack should be named or described briefly, and estimates given of its severity (Table 12) and density of occurrence (Table 13).

Figure 61 shows a crescent-shaped tearing of the surfacing which is likely caused by horizontal forces at a spot where the bond with the underlying layer is very poor.

Figure 62 shows an "elephant footprint" crack which appears almost exclusively in southern Ontario, and on thin pavement design (single course asphalt pavement >45 mm over granular grade). There may be a series of these down the centre line of the road. There may be a slight depression at the centre of the area. Possible causes are a combination of winter snow removal practise of centre bare plowing and salting, and porous mix either due to lack of compaction or mix design of the asphalt pavement.

Figure 61. Tearing Crack

Figure 62. Elephant Footprint Crack

6. Maintenance

When pavement distress leads to a rough surface condition or to a locally-dangerous bump or hole, maintenance is undertaken to either:

- seal the surface to prevent water from getting down into the susceptible layers,
- smoothen the roughened surface, or
- cure the cause of the bump or hole.

Figures 63, 64, 65 and 66 illustrate spray patching, skin patching, and hot-mix patching. Figures 67 and 68 illustrate crack sealing and crack routed and sealed.

Patching will cover and hide pavement distress. However, condition reports on the extent and type of patching, when reviewed over a period, will tend to indicate whether the pavement deficiency is structural inadequacy or is due to faulty materials or otherwise.

In reporting on the presence of patches, the density of occurrence should be estimated in the terms given in Table 3.
In reporting on the presence of sealed cracks, the density of occurrence should be estimated in the terms given in Table 16.

Examples: Extensive full-width, hot-mix patching in the section.
Extensive crack routed and sealed in the section.

Figure 63. Spray Patching

Figure 64. Skin Patching

Figure 65. Hot-Mix Recycling Patch of Alligator Cracking on Centre Line

Figure 66. Hot-Mix Patching

Figure 67. Crack Sealing

Figure 68. Crack Routed and Sealed

Appendices

Appendix A. A Guide for Completing the "Flexible Pavement Condition Evaluation Form" 46

Appendix B. A Guide for Completing "Pavement Condition Report Forms" 48

Appendix C. Distress Index (DI) – An Alternative to Pavement Condition Rating (PCR) 52

Appendix A. A Guide for Completing the "Flexible Pavement Condition Evaluation Form"

Pavement Identification
Pavement sections under evaluation must be identified by completing the following (refer also to Figure A-1).

1. District — number of district (1 to 20).
2. Highway — number of highway.
3. Work project or contract number.
4. Work project or contract length in kilometres.
5. Location — tie into the nearest town or city, major highway interchanges, or any other prominent landmarks.
6. Date of survey — time evaluation taken place.
7. Number of evaluation sections chosen within the work project or contract limits.
8. Evaluation section's number.
9. Evaluation section's length in kilometres or metres.
10. Linear Highway Retrieval System (LHRS) numbers for evaluation section.
11. Offset distance for evaluation section as related to LHRS point.
12. Pavement surface type: specified as HL1 or HL3, etc.
13. Pavement width: from edge to edge in metres.
14. Shoulder surface type: specified as gravel, hot-mix, paved, grass, etc.
15. Shoulder width: from pavement edge to rounding in metres.

Riding Quality
Riding quality rating of evaluation section is made by driving over the pavement at posted speed and the appropriate rating is recorded in the proper column in the evaluation form (Figure A-1).

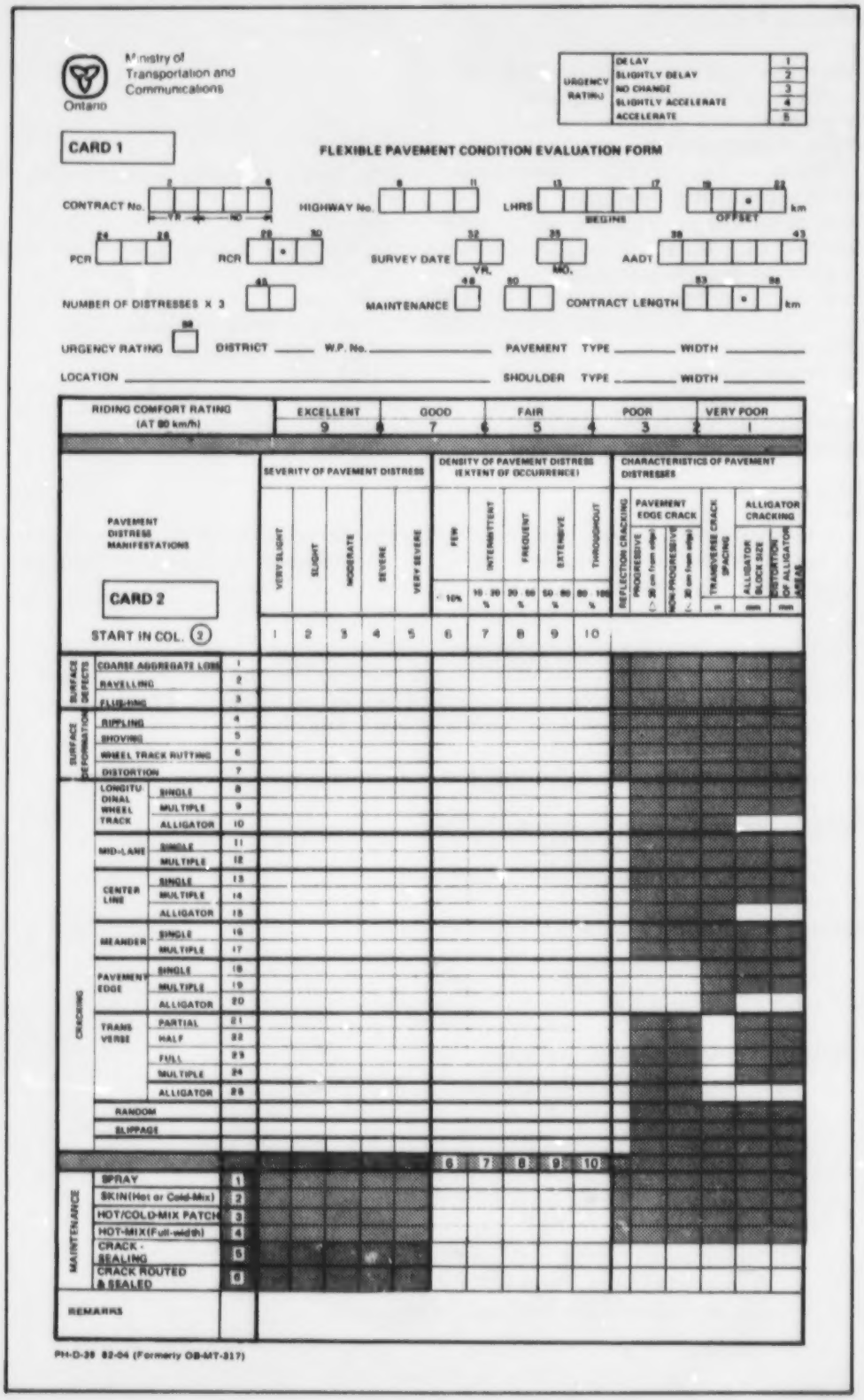
Pavement Surface Distress Manifestations
Pavement surface distress manifestations are evaluated by the rater either walking and/or driving very slowly over the evaluation section and checking off all the pavement distress manifestations in their appropriate spaces (Figure A-1).

The pavement distresses are listed under three subgroups.

1. Surface distress
   - coarse aggregate loss
   - ravelling
   - flushing
2. Surface distortion or deformation
   - rippling
   - shoving
   - rutting
   - distortion
3. Cracking
   - longitudinal wheel track
   - longitudinal mid-lane
   - centre line
   - meandering
   - pavement edge
   - transverse
   - alligator
   - random
   - slippage
   - miscellaneous (for any type of cracking which is not specifically described by the above)

Maintenance
Maintenance should be reported by its type and the density of occurrence by checking off the appropriate spaces (Figure A-1).

The performance summary based on information gathered in this "Flexible Pavement Condition Evaluation Form" is used to formulate the "Condition Rating" as given in Appendix B.



Ministry of Transportation and Communications
Ontario

URGENCY RATING: DELAY 1; SLIGHTLY DELAY 2; NO CHANGE 3; SLIGHTLY ACCELERATE 4; ACCELERATE 5

CARD 1

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

CONTRACT No. (YR. / NO.) HIGHWAY No. LHRS (BEGINS) OFFSET km

PCR RCR SURVEY DATE (YR. / MO.) AADT

NUMBER OF DISTRESSES X 3 MAINTENANCE CONTRACT LENGTH km

URGENCY RATING DISTRICT W.P. No. PAVEMENT TYPE WIDTH

LOCATION SHOULDER TYPE WIDTH

RIDING COMFORT RATING (AT 80 km/h): EXCELLENT 9 8 GOOD 7 6 FAIR 5 4 POOR 3 2 VERY POOR 1

CARD 2

START IN COL. (2)

PAVEMENT DISTRESS MANIFESTATIONS

SEVERITY OF PAVEMENT DISTRESS: VERY SLIGHT; SLIGHT; MODERATE; SEVERE; VERY SEVERE

DENSITY OF PAVEMENT DISTRESS (EXTENT OF OCCURRENCE): FEW (- 10%); INTERMITTENT (10 - 20 %); FREQUENT (30 - 50 %); EXTENSIVE (50 - 80 %); THROUGHOUT (80 - 100 %)

CHARACTERISTICS OF PAVEMENT DISTRESSES: REFLECTION CRACKING; PAVEMENT EDGE CRACK (PROGRESSIVE (> 30 cm from edge); NON-PROGRESSIVE (< 30 cm from edge)); TRANSVERSE CRACK SPACING (m); ALLIGATOR CRACKING (ALLIGATOR BLOCK SIZE (mm); DISTORTION OF ALLIGATOR AREAS (mm))

			1	2	3	4	5	6	7	8	9	10
SURFACE DEFECTS	COARSE AGGREGATE LOSS		1									
	RAVELLING		2									
	FLUSHING		3									
SURFACE DEFORMATION	RIPPLING		4									
	SHOVING		5									
	WHEEL TRACK RUTTING		6									
	DISTORTION		7									
CRACKING	LONGITUDINAL WHEEL TRACK	SINGLE	8									
		MULTIPLE	9									
		ALLIGATOR	10									
	MID-LANE	SINGLE	11									
		MULTIPLE	12									
	CENTER LINE	SINGLE	13									
		MULTIPLE	14									
		ALLIGATOR	15									
	MEANDER	SINGLE	16									
		MULTIPLE	17									
	PAVEMENT EDGE	SINGLE	18									
		MULTIPLE	19									
		ALLIGATOR	20									
	TRANSVERSE	PARTIAL	21									
		HALF	22									
		FULL	23									
		MULTIPLE	24									
		ALLIGATOR	25									
	RANDOM											
	SLIPPAGE											
								6	7	8	9	10
MAINTENANCE	SPRAY		1									
	SKIN (Hot or Cold-Mix)		2									
	HOT/COLD-MIX PATCH		3									
	HOT-MIX (Full-width)		4									
	CRACK-SEALING		5									
	CRACK ROUTED & SEALED		6									
REMARKS												

PH-D-38 82-04 (Formerly OB-MT-017)

Figure A-1. Flexible Pavement Condition Evaluation Form

Appendix B. A Guide for Completing "Pavement Condition Report Forms"

District No.
Number only of district: 1 to 20.

Hwy. No.
If highway location has more than one number, list all with the lowest number first, e.g., 7, 15 and 29.

W.P. No.
List the current work project number if applicable.

Length
Indicate the length in kilometres and decimals of a kilometre. If a discrepancy occurs between the distance table or map distance and actual car distance, use actual car distance if odometer reads correctly.

Location
The location should be referenced to the junction of highways or secondary highways, or to city or town limits. Do not refer to small villages, rivers, municipal boundaries or other landmarks which are not readily identifiable on the official road map.

The sections should run from east to west or from south to north. The current MTC Reference System number of the closest numbered location to the east or south of each end of the project should be given, together with the offset distance from this location (if any).

Last Contract No.
Indicate the number or numbers of previous contracts on the section of highway. This information will be used for input and retrieval from PAMFIS.

RCR (Riding Comfort Rating)
Indicate the Riding Comfort Rating to one decimal place based on the assessment of the ride at posted speed, e.g., 6.4. The following scale developed by RTAC should be used:

10 to 8 Excellent
8 to 6 Good
6 to 4 Fair
4 to 2 Poor
2 to 0 Very poor

Pavement

Type:	Indicate surface type only, i.e., gravel surface, surface treated, mulch, hot-mix, concrete, etc.
Width:	Measure with tape at the time of survey. If variable, show minimum and maximum widths.
Shoulders:	Estimate width or, if variable, show minimum and maximum widths.

Traffic
Indicate the year of the traffic count, the AADT and SADT and the percentage of truck traffic if known.

Soils Data
Indicate the topography and soil types. This information may be supplemented by reference to Putnam and Chapman or to Regional soil maps, if necessary.

Pavement Structure Data
Indicate any spray patching, hot-mix patching, joint sealing, or other maintenance repair work carried out and the approximate year the work was done.

Performance and Condition
This should be indicated by a detailed summary of the riding quality, surface defects, distortion and cracking. The Manual for Condition Rating of Flexible Pavements describes riding quality and various forms of pavement distress, and details the terminology to be used to describe them. The descriptive terms used in the manual have been standardized and should be strictly followed to allow accurate comparison of information from various sources.

Remarks
This section should include general comments on points such as:

- type of W.P. if this has been assigned,
- possible changes in type or volume of traffic,
- frost heaves,
- ditching,
- safety features,
- alignment, and
- possible combination with other projects.

If deflection or rebound measurements have been made to assess the strength of the pavement, the results should be indicated here. The type of measurement should be noted, i.e., Dynaflect, Benkelman Beam, etc. The data should be presented in standard form (i.e., $\bar{x} + 2\sigma$ values). The time of survey should be noted to indicate whether the data represents the maximum spring rebound values, or if the data was taken from a single survey at some other time of year.

Roughness measurements, if any, should be indicated showing the type of machine used and the data — usually in millimetres per kilometre.

Skid resistance measurements should be shown indicating skid number values and the speed at which the skid number was assessed. The method of measurement should be indicated (i.e., brake force trailer or stereo photographs).

Proposed Remedial Measures
Indicate if patching or other maintenance measures will be adequate, and indicate the year when these should be carried out. If resurfacing is proposed, indicate the type and thickness of courses required and the extent of any padding.

Program Year
Indicate the present program year, if any, and any suggested changes. If work is required within the 5-year period, indicate the year. If no work is required at present, estimate whether work will be required in 5 to 10 years or after 10 years. This estimate is of value to the Highway Program Administration Office.

Date of Survey
Indicate the day, month and year.

Condition Rating
The attached sheet gives a guide to assessing condition rating and proposed treatments. The recommendations may be varied according to the class of highway considered.

Distribution
Distribution is made to Regional Staff. Copies should be sent to the District Office and to the appropriate Head Office staff in the:

- Pavement and Foundation Design Section,
- Reference and Inventory Systems Section,
- Highway Project Control Section, and
- Research Section.

Table B-1. A Guide for the Estimation of Pavement Condition Rating and Priority for Flexible Pavements

Reconstruct within 2 years.	0 - 20	Pavement is in poor to very poor condition with extensive severe cracking, alligatoring and dishing. Ridability is poor and the surface is very rough and uneven.
Reconstruct in 2 - 3 years.	20 - 30	Pavement is in poor condition with moderate alligatoring and extensive severe cracking and dishing. Ridability is poor and the surface is very rough and uneven.
Reconstruct in 3 - 4 years.	30 - 40	Pavement is in poor to fair condition with frequent moderate alligatoring and extensive moderate cracking and dishing. Ridability is poor to fair and surface is moderately rough and uneven.
Reconstruct in 4 - 5 years or resurface within 2 years with extensive padding.	40 - 50	Pavement is in poor to fair condition with frequent moderate cracking and dishing, and intermittent moderate alligatoring. Ridability is poor to fair and surface is moderately rough and uneven.
Resurface within 3 years.	50 - 65	Pavement is in fair condition with intermittent moderate and frequent slight cracking, and with intermittent slight or moderate alligatoring and dishing. Ridability is fair and surface is slightly rough and uneven.
Resurface in 3 - 5 years.	65 - 75	Pavement is in fairly good condition with slight cracking, slight or very slight dishing and a few areas of slight alligatoring. Ridability is fairly good with intermittent rough and uneven sections.
Normal maintenance only.	75 - 90	Pavement is in good condition with frequent very slight or slight cracking. Ridability is good with a few slightly rough and uneven sections.
No maintenance required.	90 - 100	Pavement is in excellent condition with few cracks. Ridability is excellent with few areas of slight distortion.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

REGIONAL GEOTECHNICAL SECTION
PAVEMENT CONDITION REPORT

CONDITION RATING
_____

DISTRICT No. _____ HWY. No. _____ W.P. No. _____ LENGTH _____

LOCATION: _____

Reference No. From _____ To _____ Last Contract No. _____

Offset Distance _____ _____ R.C.R. _____

PAVEMENT: Type _____ Width _____ SHOULDER: Width _____

TRAFFIC: Year _____ A.A.D.T. _____ S.A.D.T. _____ % Trucks _____

SOILS DATA:

PAVEMENT STRUCTURE DATA:

MAINTENANCE HISTORY:

PERFORMANCE AND CONDITION:

REMARKS:

PROPOSED REMEDIAL MEASURES:

PROGRAM YEAR: Present _____ Suggested _____

DATE OF SURVEY: _____ PREPARED BY: _____

Figure B-1. Pavement Condition Report

Appendix C. Distress Index (DI) — An Alternative to Pavement Condition Rating (PCR)

The Pavement Condition Rating (PCR) is the final result of the combined assessment of pavement riding quality and distress manifestations.

This assessment is generally made by one or more people as are available for the task. The PCR is the average value from these raters. The assessments are made in each of the five regions of the province by the engineering staff of the Geotechnical Office.

The engineering staff maintain their standard assessment procedures through periodic calibration over a training circuit established for such purpose in the region (Figure C-1). The circuits are also used for training of new and inexperienced staff members.

However, going one step further to minimize human bias, a more objective method of assessing the PCR value of a pavement section is under development in Ontario [1]. This method uses ride roughness (RCR) and the word descriptions of pavement distress to calculate a numerical value known as the Distress Index (DI), by means of the equation

$$DI = 100\,(0.1 \times RCR)^{1/2} \times \frac{320\text{-}DM}{320} \qquad (1)$$

where Riding Comfort Rating (RCR) is the riding quality which might be a measured quantity, converted to a scale of 0 to 10, through a correlation equation [2], e.g.,

$$RCR = a + b \log \text{"Q"}.$$

The DM (Distress Manifestations) is the sum of defects obtained by summing the products of the sum of the density and severity weights multiplied by the weight for the distress type [1].

The equation shows that

$$DM = \sum_{i=1}^{27} C_i\,(S_i + D_i) \qquad (2)$$

where

C_i = weighting value for a particular type of crack or other form of pavement distress (Table C-1),

S_i = weighting value for severity of crack or other form of distress (Table C-2),

D_i = weighting value for density of occurrence of the particular crack type or other form of distress (Table C-2),

and

320 is the probable maximum value of DM.

Figure C-2 shows the plot of the calculated DI against subjectively assigned PCRs. The plot shows excellent correlation of DI with PCR throughout the province.

This new methodology is being developed so that a more systematic way of combining riding quality and pavement distress may result in more consistent and unbiased ratings for use in priority planning and effective optimization.

Additionally, the effect of DM on DI was investigated [3]. The result indicates that on a province-wide basis, DM values are generally less than 100 and the effect on DI does not exceed 30% (Table C-3).

Since DI is a function of roughness as well as distress, the following must be concluded:

> firstly, that roughness is much more important in measurement of pavement serviceability (PCR) than distress, and secondly, that distresses which affect roughness are much more significant than distresses which do not.

Additional evidence to support the second conclusion are the high weighting values (Table C-1) determined for surface distortion, rutting and alligatoring longitudinally in wheel tracks and at transverse cracks.

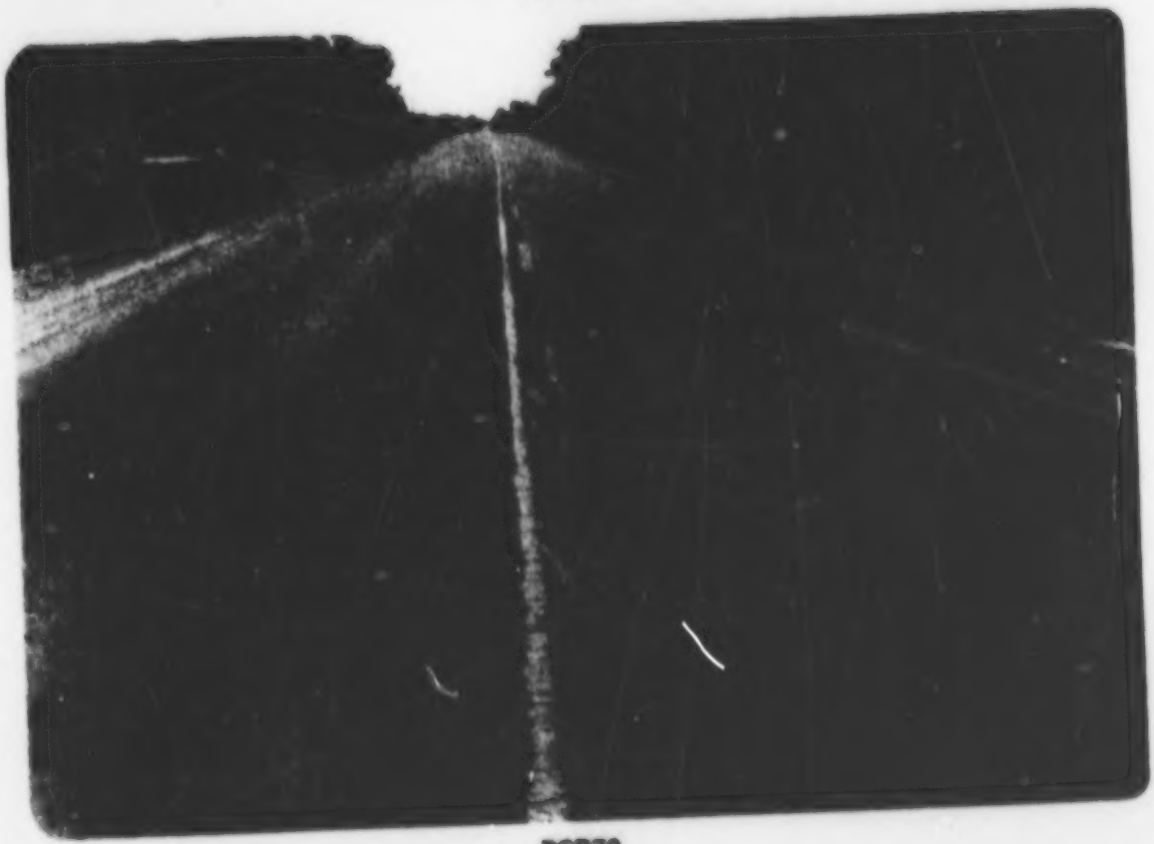
References

[1] Phang, W.A., "Pavement Condition Ratings and Rehabilitation Needs," Transportation Research Record 700.

[2] Chong, G., "Measurement of Road Ridability in Ontario," Ontario Ministry of Transportation and Communications, Report IR29, March, 1969.

[3] Phang, W.A., "Pavement Condition and Performance Observations — Brampton Test Road," presented to AAPT, San Diego, 1981.

PCR95



PCR70

Figure C-1. Typical Sections Included in Training Circuits

PCR60

PCR40

Figure C-1. Continued

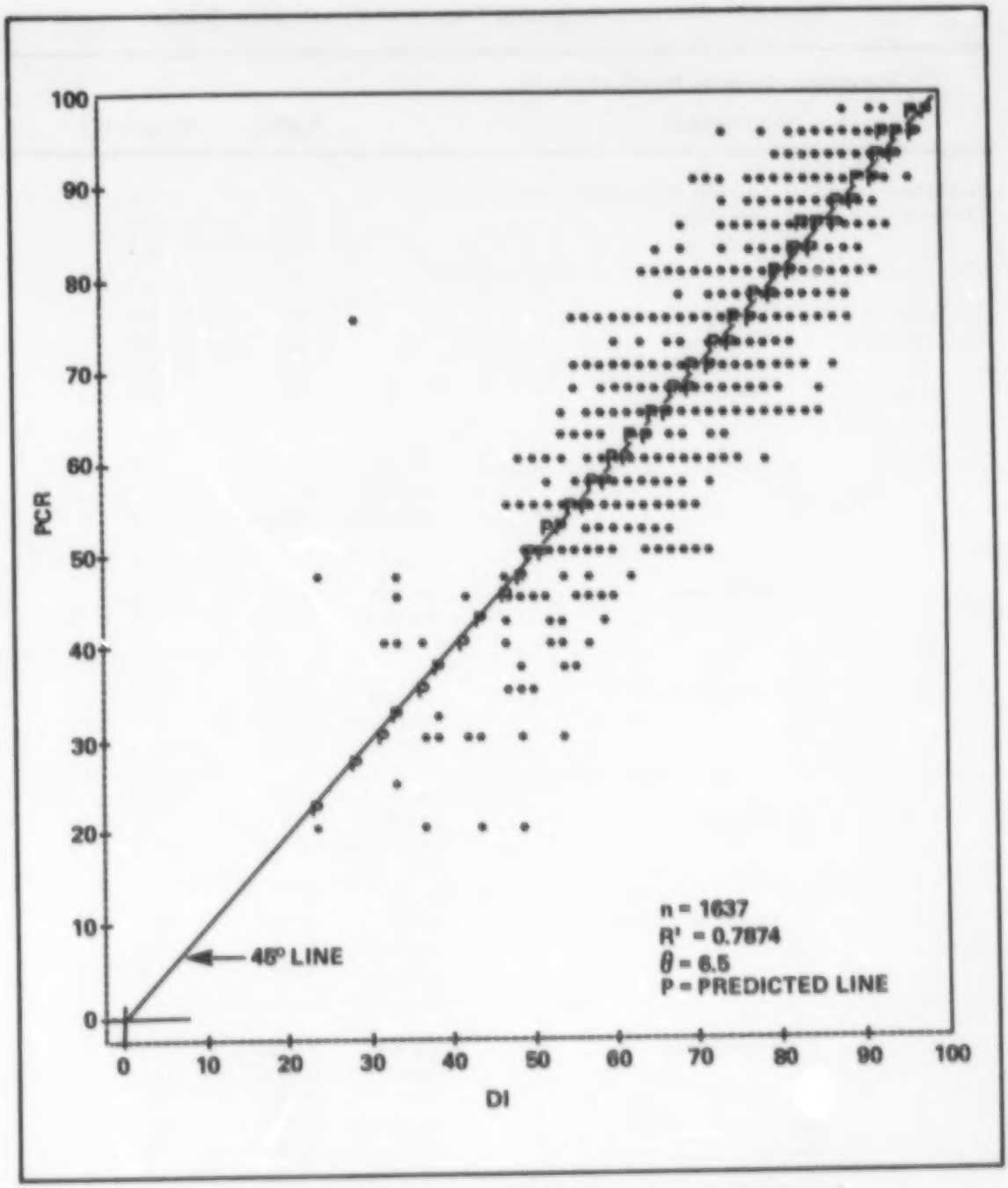


Figure C-2. PCR vs. Calculated DI (°) (based on evaluation of over 6000 km of highway in five Ontario regions)

Table C-1. Distress Weighting Factors and Description Codes

Pavement Distress Manifestations	Description		Code	Weight (C)
Surface Defects	1. Coarse Aggregate Loss		CA	3.0
	2. Ravelling		RA	3.0
	3. Flushing		FL	0.5
Surface Deformation	4. Rippling		RI	0.5
	5. Shoving		SH	0.5
	6. Wheel-Track Rutting		WR	3.0
	7. Distortion		DT	3.0
Cracking	8. Longitudinal Wheel Track	-single	S/LWT	1.0
	9.	-multiple	M/LWT	1.5
	10.	-alligator	A/LWT	3.0
	11. Mid-Lane	-single	S/ML	0.5
	12.	-multiple	M/ML	1.0
	13. Centre-Lane	-single	S/CL	0.5
	14.	-multiple	M/CL	1.0
	15.	-alligator	A/CL	2.0
	16. Meander	-single	S/ME	0.5
	17.	-multiple	M/ME	1.0
	18. Pavement Edge	-single	S/PE	0.5
	19.	-multiple	M/PE	1.0
	20.	-alligator	A/PE	1.5
	21. Transverse	-partial	P/TRV	0.5
	22.	-half	H/TRV	0.5
	23.	-full	F/TRV	0.5
	24.	-multiple	M/TRV	2.0
	25.	-alligator	A/TRV	3.0
	26. Random		RD	0.5
	27. Slippage		SL	0.5

Table C-2. Severity and Density Weights and Description Codes

Weight	Severity				Density		
D or S	Description	Code	Rut Depth cm	Crack* Width cm	Description	Code	% Length or Area
0	Very slight	0	<0.5	<0.7	Few	5	<10
1	Slight	I	0.5-1	0.7-1	Intermittent	6	10-20
2	Moderate	2	1-2	1-2	Frequent	7	20-50
3	Severe	3	2-5	2-3	Extensive	8	50-80
4	Very severe	4	>5	>3	Throughout	9	>80

*For cement-treated base, use 0.3 instead of 0.7.

Table C-3. The Effect of DM on DI

DM	Effect on DI
20	6%
40	12%
60	19%
80	25%
100	32%

POOR

QUALITY

ORIGINAL